Hybrid vehicle team to test drive new efficient dual-fuel engine

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An award-winning University of Wisconsin-Madison student hybrid vehicle will become a showcase for advanced fuel technology that harnesses the advantages of both diesel and gasoline.

The UW-Madison Hybrid Vehicle Team, which has placed first in the U.S. Department of Energy's Advanced Vehicle Competition six times in the past 20 years, is taking a break from competition to work on a new challenge, in conjunction with the UW-Madison Engine Research Center.

There, mechanical engineering professor Rolf Reitz is perfecting a new mixed-fuel technology that harnesses the advantages of both diesel and gasoline.

The process, called reactivity-controlled compression ignition (RCCI), involves two separate fuel injections: First, gasoline is swept into the engine with fresh air, with which it mixes uniformly. Then, a diesel fuel is injected, dispersed finely enough that it ignites under compression.

Mixing the two fuels allows combustion to take place at lower temperatures, which both reduces how much energy is lost in just keeping the engine hot, and minimizes the production of nitric oxides, one of the biggest culprits in vehicle-related air pollution.

The technology also reduces greenhouse gas emissions. Because the process involves pulling in fresh air, more so than standard combustion, leftover carbon is more likely to react with oxygen to form carbon dioxide, rather than being expelled as soot.

"Everyone finds a dancing partner, so we don't get solid carbon coming out," says Glenn Bower, a mechanical engineering faculty associate and UW vehicle team advisor. "The air coming out is as clean as the air in Wisconsin."

Using RCCI, Bower estimates the team vehicles will emit 75 percent fewer greenhouse gases, surpassing the 2010 vehicle emission standards with minimal after treatment.

Furthermore, RCCI engines can achieve efficiencies of between 20 and 35 percent better than with standard diesel engines, which are themselves about 20 to 30 percent more efficient than gasoline engines.

"Fundamentally you can't get too much better than this," Bower says. "You can't eliminate friction, but we're getting pretty close to the maximum amount of mechanical energy we can get from breaking a chemical bond."

For additional "green" benefits, Bower's team will use ethanol instead of gasoline, and biodiesel instead of standard diesel.

The team is converting two of its former competition vehicles for this purpose. The first, a Saturn Vue called the eMOOve, will be a series hybrid, to be completed in 2012. A series hybrid is an electric vehicle with an on-board generator: the generator operates at one speed, and therefore requires calculating only one ideal fuel mixture.

By 2013, the team will also convert its Chevy Equinox, called MOOVADA, to be a parallel hybrid, in which the battery and the engine work together. This will take more work because the engine must operate smoothly at about 1,000 different engine speeds and loads, Bower says.

"Rolf Reitz's graduate student team is hectically converting and calibrating engines for RCCI. As the engines become available, the undergraduates in the Hybrid Vehicle Team will integrate them into functioning hybrid vehicles," he says.

Bower says he hopes incorporating the RCCI engine technology into a vehicle will encourage industry leaders to adapt it for vehicles and even stationary power generators.

One hurdle, though, will be the fuel infrastructure. In order to fuel an RCCI engine, a gas station pump must be able to dispense both gasoline or ethanol, and diesel or biodiesel, simultaneously.

"We always have to battle fuel infrastructure," Bower says. "But we do have diesel fuel and we usually have ethanol that's fairly readily available. The idea of basically having a pump with dual nozzles filling both tanks simultaneously isn't out of the question, because they already have the tanks."

More information: vehicle.slc.engr.wisc.edu//

Provided by University of Wisconsin-Madison

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